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POLYSACCHARIDE-BASED NANOCOMPOSITES FOR GENE DELIVERY AND TISSUE ENGINEERING



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Woodhead Publishing Series in Biomaterials

Polysaccharide-Based Nanocomposites for Gene Delivery and Tissue Engineering

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Description

Polysaccharide-Based Nanocomposites for Gene Delivery and Tissue Engineering presents quantitative background on new polysaccharide nanocomposites in a clear and logical way, highlighting the most exciting applications in gene delivery and tissue engineering and their progress. The book focuses on the different types of polysaccharide nanocomposites for gene delivery and tissue engineering and covers

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Jawaid received the Excellent Academic Award in the Category of International Grant-Universiti Putra Malaysia—2018 and also the Excellent Academic Staff Award in Category of industry High Impact Network during Community and Industry Network (ICAN 2019). Beside that he also won Gold Medal during JINM Showcase under Community and Industry Network Category at Universiti Putra Malaysia, Malaysia. He also received the Publons Peer Review Awards 2017, and 2018 (Materials Science), Certified Sentinel of Science Award Recipient—2016 (Materials Science) and 2019 (Materials Science and Cross Field). He is the winner of the Newton-Ungku Omar Coordination Fund: UK-Malaysia Research and Innovation Bridges Competition 2015. Recently he was recognized with a Fellow and Chartered Scientist Award from the Institute of Materials, Minerals and Mining (IOM), UK. He is also a lifetime member of the Asian Polymer Association, and the Malaysian Society for Engineering and Technology. He has professional membership of the American Chemical Society (ACS) and the Society of Plastics Engineers (SPE), USA.

Preface

This book provides solid, quantitative descriptions and reliable guidelines, reflecting the maturation and demand of the field and the development of new polysaccharide nanocomposites. It focuses on the different types of polysaccharide nanocomposites of cellulose, chitosan, alginate, etc. for gene delivery and tissue engineering. The book also covers polysaccharide hydrogels for tissue engineering and polysaccharide magnetic nanocomposites for gene delivery and highlights the most exciting applications in the field of gene delivery and tissue engineering. This book will be of interest to researchers working in the fields of material science, biomaterials, regenerative medicines, drug delivery, tissue engineering, polymer science/chemistry, and chemical engineering, and in the polymer industry. It will be useful for scientists working on polysaccharide nanocomposites for gene delivery and tissue engineering. The book will be very helpful for students in the development of new polysaccharide nanocomposites as well as graduates in polymer technology, biomedical science, and biotechnology.

The two introductory chapters cover basic information about polysaccharides and nanocomposites, to provide a foundational understanding. The second section of this book covers chitosan and its derivatives-based dimensional frameworks as carriers for gene delivery, alginate- and hyaluronic-based hydrogels for tissue engineering, heparin- and cellulose-based nanocomposites for and dextran, pullulan, gellan, xanthan, and xanthun gum-based nanocomposites for tissue engineering applications. The last section describes polysaccharide-based 3D bioprinter inks for tissue engineering, polysaccharide-based nanocomposites for gene delivery, chitosan- and starch-based nanocomposites for gene delivery, and hyaluronic acid magnetic nanocomposites for gene delivery.

Finally, we assure the readers that the information provided in this book can serve as a very important tool for anyone wishing to select/design polysaccharide-based nanocomposites to fulfil the requirements of gene delivery and tissue engineering applications. We are grateful to all the authors who contributed chapters to this book and who helped to turn our thoughts into reality. Lastly, we are grateful to the Elsevier team for their continuous support at every stage to make it possible to publish on time.

Showkat Ahmad Bhawani
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Polysaccharides

1

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1.1 Introduction

Natural polysaccharides are generally constituted of simple carbohydrates with long chain molecules attached via glycosidic linkages. Carbohydrates are made up of aldehydes or ketones, and have multiples hydroxyl groups. They make up the majority of organic matter and play a crucial role in human life. Carbohydrates serve as energy stores, fuel, and various metabolic intermediates. In parallel, various sugars like ribose and deoxyribose form part of the structural framework of RNA and DNA. Polysaccharides are also present in the cell walls of bacteria and plants, and cellulose is the main constituent of plant cell walls [1, 2].

The most authentic classification performed for polysaccharides is based on degree of polymerization (DP). Polysaccharides may reach a DP of 10^7 , whereas, by definition, the maximum DP for oligosaccharides is 10. Hence, by convention, compounds having a DP of 11 or more are designated polysaccharides. A monosaccharide is a monomer of saccharides, and a disaccharide is two conjugated monomers [1, 3].

Many studies are available related to the general introduction of polysaccharides, their chemical structures, chemical compositions, methods of isolation, types, etc. [4–7]. Hence, in this chapter, a very interesting aspect is explained: the nano-form of these polysaccharides, which is an area of emerging interest in scientific studies. Very few studies in the literature have been summarized related to nano-polysaccharides characterization, the isolation process, and their properties and applications. Consequently, this chapter explains the collective efforts and provides a summary of nano-polysaccharide understanding and their utilization in various applications.

1.2 Natural polysaccharide nanomaterials

Polysaccharides are molecules composed of monomer sugar units linked by glycosidic bonds; this bond is responsible for the attachment of monomers and forms polymers. They are the most abundant natural polymer on Earth [8, 9]. The amount of polysaccharide produced by plants per year exceeds by several orders of magnitude the synthetic production by the chemical industry [10]. Natural polysaccharides (Table 1.1)

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